Earth's Atmosphere

ES-4 The student will demonstrate an understanding of the dynamics of Earth's atmosphere.

ES-4.3 Summarize the cause and effects of convection within Earth's atmosphere.
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/future knowledge: Students were introduced to the concepts in this indicator in 6th grade (6-4.8). This study included explaining how convection affects weather patterns and climate. In Earth Science students will develop concept of the cause of convection within the atmosphere.

It is essential for students to know that *convection* is the transfer of heat energy in fluids, liquids or gases, by the movement of the heated particles.

- In convection, particles with higher energy move from one location to another carrying their energy with them.
- Particles with the higher energy move from warmer to cooler parts of the fluid.
- Because of Earth's spherical shape, the Sun's rays strike Earth more directly at the tropics than they do at the poles. At the poles, the same amount of solar radiation is spread over a larger area than at the equator. This unequal heating sets up the warmer-cooler regions necessary for global convection to take place in the atmosphere.

The air flowing from the equator completes three looping patterns of flow called *convection cells*. There are three atmospheric convection cells in the northern hemisphere and three in the southern hemisphere.

- The *tropical convection region* begins at the equator and extends to the about 30 degrees north or south latitude – warm air rises at the equator then cools enough to descend at about 30 degrees latitude from which air flows both north and south;
- The *temperate convection region* extends from there to about 60 degrees north or south latitude – descending air moves either back toward the equator or toward the poles where the air at about 60 degrees and warmed enough to create a low pressure area and again rise;
- The *polar convection region* extends from there to the poles, 90 degrees north or south latitude – air at the poles is descending cold air that moves toward the equator; at about 60 degrees it has warmed enough to begin rising.

Students should understand convection on a global scale in the atmosphere, which causes global winds, and therefore is the mover of weather systems in particular directions.

- Due to the spinning of Earth, the weather systems in these convection cells move in certain directions because the *global wind belts* are set up (ES-4.5).
- On a smaller scale, convection currents near bodies of water or near mountains can cause local winds known as *land and sea breezes* or *mountain and valley breezes*.

Because of the unequal heating of Earth, *climate* zones (tropical, temperate, and polar) also occur.

- Since temperature is a major factor in climate zones, students should relate climate to the convection regions at various latitudes, to temperature differences between the equator and the poles, and also to warm and cold surface ocean currents.

It is not essential for students to know the cause and effects of radiation (other than the angle of solar radiation) and conduction on the atmosphere. This indicator is not a complete study on the conditions related to climate. Climate is only related as an effect of global convection.

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Assessment Guidelines:

The objective of this indicator is to *summarize* the cause and effects of convection; therefore, the primary focus of assessment should be to generalize major points about how convection cells are caused and their effects within the atmosphere.

In addition to *summarize* assessments may require students to:

- *interpret* diagrams of convection cells;
- *explain* how the angle of solar radiation affects heating of Earth; or
- *compare* convection regions to the global wind belts.